# Acceptance of augmented reality in video conference based learning during COVID-19 pandemic in higher education

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**ABSTRACT**

Three years after the COVID-19 pandemic emerged, we have adapted to the new normal, especially in the education field. Learning with video conferences has become our daily activity, and learning tools have gotten more prominent attention to gain student engagement, especially in emergency remote teaching (ERT). Since the trends of metaverse campaigns by meta, augmented reality (AR) has increased recognition in education contexts. However, very little research about the acceptance of augmented reality in video conferences, especially among university students. This paper aims to measure acceptance of AR in video conferences to motivate and inspire students to gain benefits and get impactful technology in the learning process. The research gathered data from a survey of 170 university students (from 5 majors in the study program and 17 different demographic areas) using unified theory of acceptance of technology 2 (UTAUT2). The result reveals that variables significantly impact acceptance: performance expectancy, hedonic motivation, and habit. The least significant but still positive effects are effort expectancy, social influence, and facilitating conditions. The study will provide helpful information on AR technology in video conferences and help top-level management in the university that provides online/distance learning in the early diffusion stage for metaverse in education.



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## 1. INTRODUCTION

Three years after the pandemic has emerged, people tend to prepare for new normal activities, especially in higher education. The use of emergency remote teaching (ERT) have pushed educator to rethink their roles and technologies to support them [1]. As part of implementing ERT to reduce the spread of Pandemic in the education sector, one of the best learning strategies is using video conference [2]. Full-screen video and audio are used in video conferences, which can be point-to-point or bridged multipoint. Most systems also support source inputs from document cameras and screen sharing. High-speed data is used to transmit data signals over the internet (IP model) [3].

Although video conferencing is manufactured to enhance productivity and maximize business efficiency, its usage for educational purposes has been widespread [4]. Research also said that video conferences significantly influence satisfaction and interest in a more active way of learning [5]. Some video conferencing technologies are Microsoft Team meetings, Google meets, and Zoom video conferences [6]. In this research, university students and lecturers use Zoom video conference as the primary communication tool for delivering content. Unfortunately, video conferences are challenging to attract students' attention since they are less supervised by the lecturer [7]. It is also recommended to avoid long presentations, especially for the primary consideration of attention span [8]. Thus, another learning technology is introducing student engagement, from the education games [9] to the novel, augmented reality (AR).

AR implementation in education has been researched and made a positive contribution in the education context [10], [11], academic impact [12], and also pedagogy impact [13]. Research also reveals that AR has positively impacted other businesses [14]. Many solutions such as reshaping the business process and strategies, the critical role in digital marketing strategies [15], influencing our social life experience [16], making new schemes of gaming experience [17], and creating a new level of advertising media like public large display [18], tourism and travel industries [19], designer and architecture [20]. Together with VR [21], AR technology has contributed to creating a new trend in the metaverse. AR can overlay in front of the users' physical surroundings, creating seamless and lightweight user interaction, bridging human users in the world physical with the metaverse [22].

Besides the advantages of the user AR in education, The learning process can become more interactive, motivated, engaged, and immersive by addressing a number of potential issues with the learning environment's architecture [23]. Also, research finds that AR is a technology that is difficult for students to use because of its usability [24]. Many researchers have positively impacted AR in education video conferences during ERT. Still, it seems minimal research combines video conference and AR technology as one combination to increase student motivation, engagement, and interactivity.

The motivation of this research is to combine AR as a teaching tool with video conference and get the measurement of how acceptance of these technologies by university students. A careful selection of topic-related has been chosen to insert AR in the video conference-based learning activities. The scenario is about the new technologies topic, including E-commerce, since AR has also been tested in online services to improve online retailing as part of commerce that can improve the service experience [25].

This research is explanatory research that examines the acceptance of one variable to another through hypothesis. Many empirical studies measure factors that influence and acceptance of technology adoption. One widely cited model in IS/IT artifacts is the technology accepted model (TAM) [26]. However, some researcher reports that TAM is neglected adequate insight into the individual perspective of the novel system [27]. Thus, Venkatesh proposed the unified theory of acceptance and use of technology (UTAUT) [28], because the theory of reasoned action (TRA), the TAM, the motivational model (MM), the theory of planned behavior (TPB), the combined TAM and TPB (C-TAM-TPB), the model of PC utilization (MPCU), the innovation of diffusion theory (IDT), and the social cognitive theory (SCT) are the eight fundamental components on which UTAUT is based. Many researchers use it because it was developed to explore the acceptance of innovations in individual behavior [28] and focus on workplace technology acceptance [29]. There are four constructs in UTAUT: performance expectancy, effort expectancy, social influence, and facilitating condition. UTAUT model has resulted in about 70% success in exploring variant acceptance in using technology [30].

UTAUT2 was extended from UTAUT because it adds some construct to explain the acceptance of technology in consumer use [31]. The goal is to identify three major constructs, add revisions from the previous UTAUT, and explore new relationships because new technology is adapted tremendously [32]. Those three new constructs are hedonic motivation, price value, and habit. UTAUT2 has been applied to analyzing behavioral intention to use various educational technologies [33], but not in the video conference.

The literature review conducted in a similar study concluded that using UTAUT2 can help measure acceptance of AR with University Students in a video conference (process to use the technology) [34]-[37]. UTAUT2 uses eight primary constructs to influence University Students toward acceptance of technology AR to support video conferences. There are eight variables: effort expectancy (EE), performance expectancy (PE), social influence (SI), facilitating conditions (FC), price value (PV), hedonic motivation (HM), habit (HB), and habit toward behavioral intention (BI) [32]. This research focused on the effect of PE, EE, SI, FC, HM, and HB and excluded PV because it only uses existing students' smartphones. There is no cost of financing from the university students' sides, and it is not easy to evaluate the cost from students perspectives [38].

We hypothesize that: i) performance expectancy will positively affect and be significant in BI as an acceptance of AR technology in video conference-based learning, ii) effort expectancy will positively affect and be significant in BI as an acceptance of AR technology in video conference-based learning, iii) social influence will positively affect and be significant in BI as an acceptance of AR technology in video conference-based learning, iv) facilitating conditions will positively affect and be significant in BI as an acceptance of AR technology in video conference-based learning, v) hedonic motivation will positively affect and be significant in BI as an acceptance of AR technology in video conference-based learning, vi) habit will positively affect and be significant in BI as an acceptance of AR technology in video conference-based learning.

## 2. METHOD

Nowadays, video conferences are still used as the main tools to deliver lectures/content in the University, with ERT reason or just regular teaching and learning during pandemic COVID-19. As a new technology concept, AR technology has been proven to increase student engagement during class activities. Thus, we will use UTAUT2 as acceptance in video conference-based learning. An empirical study using AR technology experience and a survey was designed and conducted to test. Variables that construct the test based on UTAUT2 are EE, PE, SI, FC, HM, HB, and habit toward BI. Performance expectancy defines how the participants perceive that the use of AR technology will improve their learning outcomes. Effort expectancy determines the level to which a participant believes that AR technology will be easy to use. Social influence defines as the level to which a participant believes that important other's beliefs influence AR technology. The facilitating condition establishes the level to which a participant acknowledges that the infrastructure can support AR technology. Hedonic motivation is the level to which a participant believes that AR technology influences emotional feelings and responses. Habit is the degree to which participants tend to carry out behaviors automatically as a result of learning, which results in a preference for using a specific technology.

As part of the synchronous delivery method, video conference is set to 90 minutes maximum in one academic meeting. Usually, the lecturer will give five up to ten minutes to recall the content from the last session and provide information about the objective in this introductory session. We have inserted AR technology as content in the introductory session of this research. The introductory session will play as a prominent role in attracting students' attention [39]. The process is shown in Figure 1, as research activities during video conference sessions.

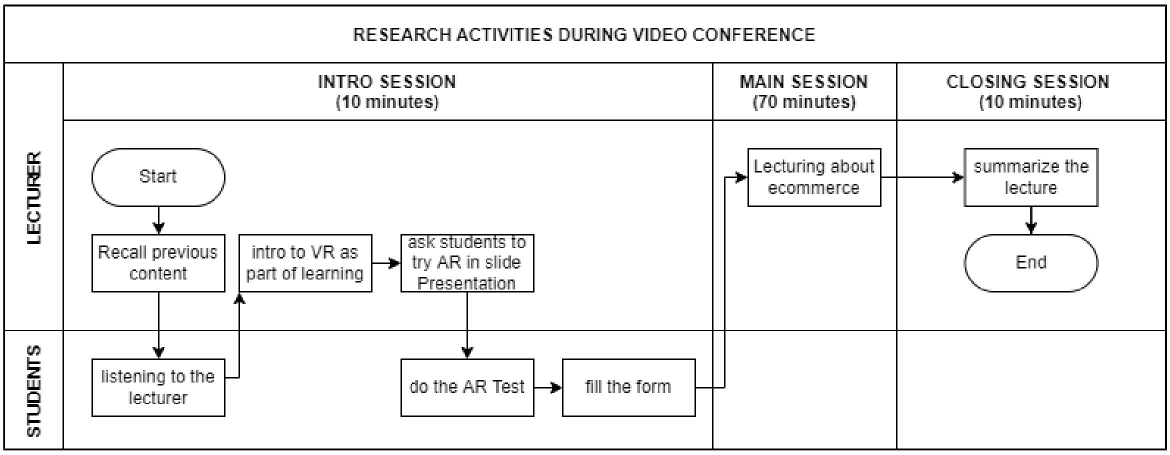


Figure 1. Research activities during the video conference

The lecture starts the introduction session by recalling the previous contents and introducing AR technology as part of the content in the Zoom video conference, as shown in Figure 2. After that, the student will be asked to try the AR test in the slide presentation given by the lecturer. The topics are about E-commerce and its technology in the future. University students as participants will introduce capture screens of the famous E-commerce websites as shown in Figure 3.

Participants will compare with the same capture screen but replace the image of luxury bags with the QR code as the trigger to AR provided by the lecturer. Without further explanation, The Participants will open their smartphones and scan QR with their camera, see the bags with AR, and listen to the lecturer's sound presenting the bags, as shown in Figure 4. There are brief step-by-step activities participants should be done: i) participants opened camera apps and saw QR codes on the slide presentation screen, ii) camera apps will show a link to open a website AR (mywebar.com), iii) participants view the QR code once again and automatically see a 3D image shown together with a narration voice introducing the bags for a minute, and iv) participants listened to the narration while moving the camera apps to view from many angles.

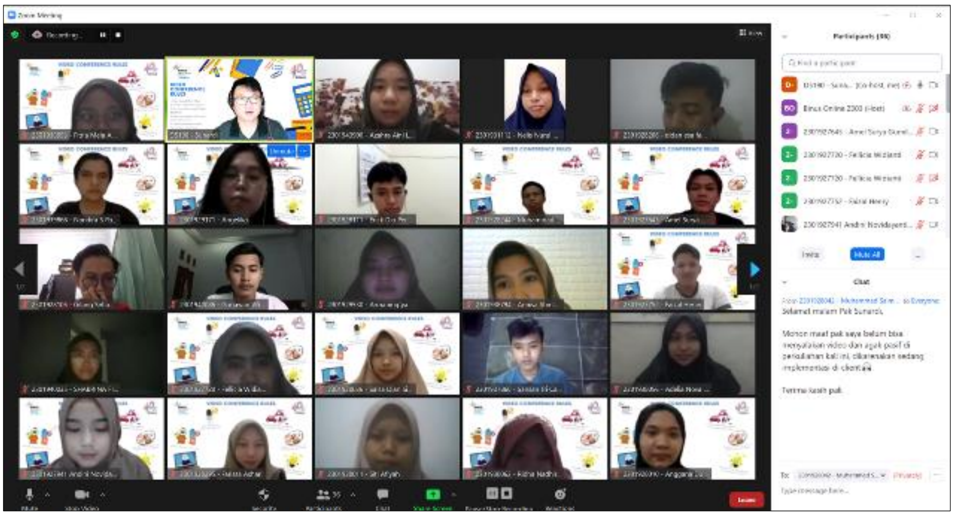

Figure 2. Zoom video conferences

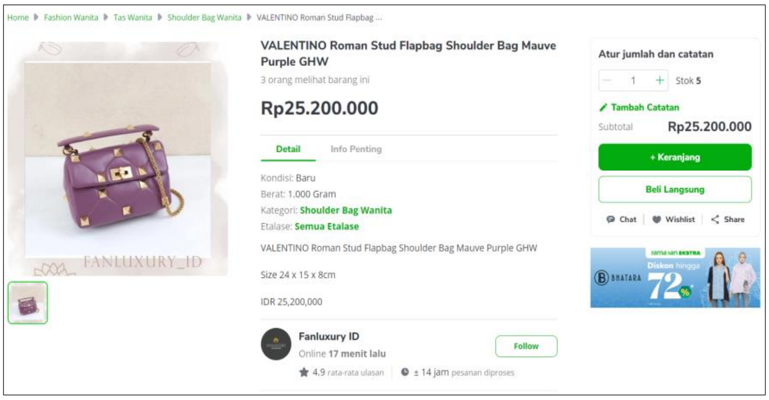


Figure 3. Luxury bags on E-commerce website

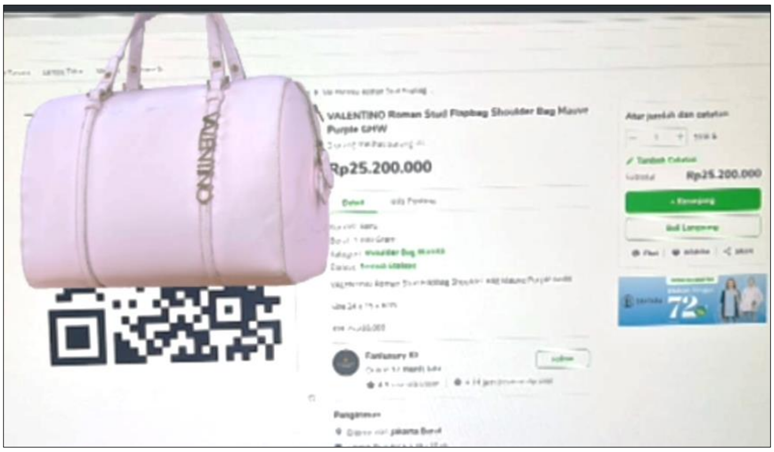

Figure 4. Luxury bags on AR view

After the participants experienced AR on their smartphones, they were requested to fill out the digital form about the UTAUT2 questionnaire, as informed in Figure 1. A 5-point Likert scale (1=strongly disagree to 5=strongly agree) was the seven dimensions of the UTAUT2 model were measured. The survey questionnaire uses three sections. The first section gives information about AR technology in the video conference to improve students' engagement and motivation in learning. The second section is about the participants' demographic, and the last section includes 26 questions on the construct of UTAUT2 [40]. The whole process took approximately 10 minutes. All the experiments were done in the evening time in early April 2022. Five study programs have been chosen because they relate to E-commerce material on its curriculum. Of nearly 200 university students watching the video conference repeated in four classes, only 170 participants filled the questionnaire. A few don't succeed in processing the activities because of a lack of a smartphone (their smartphone is used as a zoom video conference client).

We collected results and drafted 170 participants (67 males and 103 females) for the experiment. Age ranged from 19 to 49 (mean 25.97 and median 24). The participants are from 5 majors (industrial engineering, information systems, computer science, business management, and accounting) with the same topic (E-commerce). Because the participants are in the video conference, their physical location is spread in 17 provinces in Indonesia, which means their presence likely represents the most participant in university students. Two significant demographic areas are DKI Jakarta and West Java since it is Indonesia's capital city and big city. The demographic result is shown in Table 1. Finally, SmartPLS [41] analyzed the empirical data with path analysis.

Table 1. Demographic result

| Category | Item | Frequency | Percentage (%) |
|---|---|---|---|
| Gender | Male | 67 | 39 |
| | Female | 103 | 61 |
| Age | 19-23 | 75 | 44 |
| | 24-28 | 61 | 36 |
| | >29 | 34 | 20 |
| College | Industrial Engineering | 16 | 9 |
| | Information System | 55 | 32 |
| | Computer Science | 15 | 9 |
| | Business Management | 80 | 47 |
| | Accounting | 4 | 2 |
| Category | Provinces | Frequency | Percentage (%) |
| Demography | Bali | 1 | 1 |
| | Banten | 13 | 8 |
| | DI Yogyakarta | 3 | 2 |
| | DKI Jakarta | 52 | 31 |
| | Jambi | 2 | 1 |
| | Jawa Barat | 57 | 34 |
| | Jawa Tengah | 11 | 6 |
| | Jawa Timur | 11 | 6 |
| | Kalimantan Selatan | 2 | 1 |
| | Kalimantan Timur | 4 | 2 |
| | Kepulauan Riau | 1 | 1 |
| | Maluku Utara | 1 | 1 |
| | Nusa Tenggara Barat | 1 | 1 |
| | Sulawesi Tengah | 1 | 1 |
| | Sumatera Barat | 1 | 1 |
| | Sumatera Selatan | 3 | 2 |
| | Sumatera Utara | 6 | 4 |

## 3. RESULTS AND DISCUSSION

It is crucial to perform statistical validation in order to evaluate how well the model fits the data. As a requirement of statistical data, we define the construct of reliability as the capacity to measure consistency and the construct of validity as the extent to which the instrument is intended to measure. The analysis of the reliability coefficient for this Likert scale uses Cronbach's Alpha to measure the internal reliability of the construct. All seven-question groups have>0.80 Cronbach's Alpha value, which indicates the items measured in this scale have good internal consistency [33]. In this analysis, the value of composite reliability (CR) for better reliability estimation is also more than 0.70, which indicates the measured items are reliable. Average variance extracted (AVE) or grand mean value of square loading is used to access the construct validation. The standardized root means square (SRMR) has the value of 0.053, and normed fit index (NFI) has the value of 0.831 for the estimated model. Those numbers indicate a good model fit [42]. Therefore, this analysis confirmed that the factors in the UTAUT2 model provided an acceptable means to describe the acceptance of AR in the video conference. To illustrate the construct of UTAUT2, we can see Figure 5. As path analysis and result between variable into behavioral as acceptance of AR as the new technology.

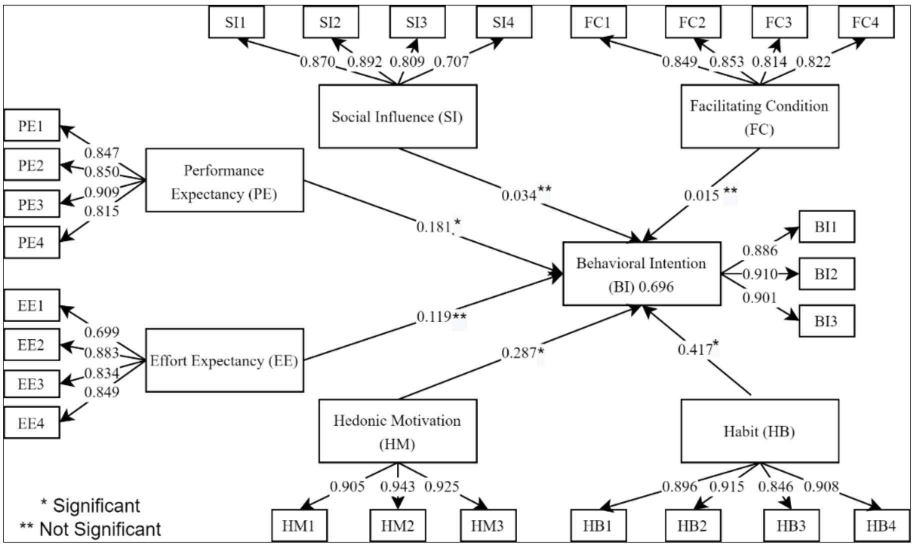


Figure 5. UTAUT2 model construct

### 3.1. Performance expectancy

Performance expectancy is defined how the participants perceive that the use of AR technology will improve their performance during the learning process. Performance expectancy has solid evidence and an impactful influence on adopting educational technology innovations [43], [44]. The performance expectancy has an average result of 4.24. Performance expectancy also positively affects behavioral intention. The effect is significant as the path coefficient value is 0.181 and the t statistic value is 0.009, or p-value<0.05. Therefore, the performance expectancy for augmented reality in video conferences has a positive and significant relation to behavioral intention.

### 3.2. Effort expectancy

Effort expectancy is defined as determines the level to which a participant believes that AR technology will be easy to use. When predicting user intention using AR technology, effort expectancy is important [45]. The path coefficient for the effort expectancy is 0.119, and the t statistic value is 1.868, or p-value>0.05, indicating that effort expectancy is insignificant to behavioral intention. However, the means of the Likert scale for the effort expectancy is 3.89. Therefore, the effort expectancy has a positive effect but is insignificant to the behavioral intention.

### 3.3. Social influence

Social influence is defined as the level to which a participant believes that important other's beliefs influence AR technology. Some studies informed that the social aspect is an invaluable force in reshaping human behavior toward accepting new technology [45]. Social influence positively affects behavioral intention as the means for social influence is 3.89. However, the effect is insignificant to behavioral intention as the path coefficient value is 0.034 and the t statistic value is 0.439, or p-value > 0.05.

### 3.4. Facilitating condition

Facilitating condition is defines the level to which a participant believes that the infrastructure can support AR technology. Some studies informed that facilitating conditions in education, such as the healthcare and the tourism field, has proven that enhancing students' intentional behavior to adopt AR technology is an invaluable force in reshaping human behavior towards the acceptance of new technology [46]. The path coefficient value for the facilitating condition is 0.015, while the t statistic value is 0.223. The numbers indicate p-value>0.05. Thus, making the facilitating condition has an insignificant effect on behavioral intention. However, the facilitating condition has a positive effect on behavioral intention. It can be seen in the average Likert scale, which is 3.80.

### 3.5. Hedonic motivation

Hedonic motivation is the level to which a participant believes that AR technology influences emotional feelings and responses. Based on the previous finding, the participant will accept technology if their motivations are fulfilled [47]. The average Likert scale for hedonic motivation is 4.27, which means hedonic motivation positively affects behavioral intention. The effect is also significant as the path coefficient value is 0.287 and the t statistic is 4.073, or p-value<0.05. Therefore, hedonic motivation has a positive effect and is significant to behavioral intention.

### 3.6. Habit

The habit is the degree to which people tend to carry out behaviors automatically as a result of learning, which results in a preference for the use of a specific technology. The construct has an average of 3.55 on the Likert scale. Thus, making habits has a positive effect on behavioral intention. The result is significant because the path coefficient value is 0.417, and the t statistic value is 6.342, or p-value<0.05. Therefore, the habit has a positive effect and is significant to behavioral intention. In summary, the construct is the list in Table 2.

Table 2. Descriptive analysis

| Constructs | Means | Standard deviation | Cronbach 's Alpha | CR | Average variance extracted (AVE) |
|---|---|---|---|---|---|
| PE | 4,24 | 0,70 | 0,88 | 0,92 | 0,73 |
| I think AR is useful in the Vicon learning | 4,31 | 0,69 | | | |
| Using the AR would increase my motivation to learn new things | 4,37 | 0,66 | | | |
| Using the AR would enhance my effectiveness in learning things faster | 4,21 | 0,69 | | | |
| Using the AR would improve my academic performance | 4,07 | 0,72 | | | |
| EE | 3,89 | 0,78 | 0,84 | 0,89 | 0,67 |
| Learning how to use AR tool is easy | 3,82 | 0,84 | | | |
| The interaction with this AR tool is clear and understandable | 4,01 | 0,76 | | | |
| I would find the AR tools is easy to use | 3,91 | 0,75 | | | |
| It would be simple for me to develop proficiency with these AR tools. | 3,84 | 0,73 | | | |
| SI | 3,89 | 0,81 | 0,86 | 0,89 | 0,67 |
| Important people in my life believe that I should utilize these kind of AR tools. | 3,74 | 0,85 | | | |
| Important people in my life believe that I should utilize AR tools. | 3,76 | 0,81 | | | |
| In general, the college authorities have supported the use of the AR tools | 3,88 | 0,77 | | | |
| In general, my lecture is very supportive of the use of the AR tools | 4,18 | 0,73 | | | |
| FC | 3,80 | 0,86 | 0,91 | 0,90 | 0,70 |
| I possess the requisite resources for utilizing AR tools. | 3,76 | 0,92 | | | |
| I possess the essential understanding to utilize AR tools. | 3,74 | 0,92 | | | |
| AR tools is compatible with other learning systems I use | 3,88 | 0,83 | | | |
| I could get help from others if I have difficulties using this kind of AR tools | 3,82 | 0,76 | | | |
| HM | 4,27 | 0,71 | 0,92 | 0,95 | 0,86 |
| AR tools presented in the video looks fun | 4,29 | 0,69 | | | |
| AR tools presented in the video looks enjoyable | 4,24 | 0,71 | | | |
| AR tools presented in the video looks very entertaining | 4,28 | 0,74 | | | |
| HB | 3,55 | 0,95 | 0,88 | 0,94 | 0,80 |
| AR has become a habit for me | 3,48 | 0,93 | | | |
| I am addicted to using AR | 3,53 | 1,00 | | | |
| I must use AR | 3,71 | 0,90 | | | |
| Using AR has become natural to me | 3,49 | 0,95 | | | |
| BI | 4,01 | 0,76 | 0,84 | 0,93 | 0,81 |
| I intend to use AR tools for learning in the near future | 3,99 | 0,78 | | | |
| I would use the AR tools in the near future | 4,04 | 0,76 | | | |
| I intend to make use of the system in the not-too-distant future. | 3,99 | 0,75 | | | |

### 3.7. Discussion

Only three significantly affected behavioral intention of the seven constructs: performance expectancy, hedonic motivation, and habit. In the performance expectancy, the question with the highest average is “using the AR would increase my motivation to learn new things,” with a value of 4.37. The overall average for all of the questions in this construct did not go below 4.00. Thus, performance expectancy has the highest standard and positive effect on behavioral intention. This result implies that users are willing to use augmented reality to increase the motivation to learn new things, enhance effectiveness to learn faster, and improve academic performance. Augmented reality is also considered useful in a video conference as a learning activity. Hedonic motivation also has a significant effect on behavioral intention. Most participants agree that augmented reality looks fun, enjoyable, and entertaining. It implies that augmented reality can catch people’s attention and interest especially in emotion responses [48]. Thus, people are more likely to use augmented reality to make the learning process more entertaining.

Another construct that has a significant effect on behavioral intention is habit. Although the average value is not as high as the performance expectancy and hedonic motivation, habit also positively affects behavioral intention. It implies that AR in the learning process may become a habit for the respondents. With the habit's significant effect on the behavioral intention, people will use AR more and apply it in the learning process. The remaining constructs, effort expectancy, social influence, and facilitating condition, are not affecting behavioral intention significantly. Although the three constructs also have a positive effect on behavioral intention. It implies that easy-to-use augmented reality tools, influence from social circles, and the available resources to use AR are not significantly affecting behavioral intention. These findings lead to management decisions to prepare the learning environment with the newest technologies such as better AR performance [49], haptic feedback system [50], hybrid tracking [51], and further research to enhance UTAUT2 and correlation with the various learning style. This research was conducted in a limited time and only used the Likert scale as the measurement. Also, by conducting an interview, further information from the respondents will help understand the acceptance of augmented reality in the learning process.

## 4. CONCLUSION

Many scholars seek solutions to support teaching and learning activities in preparation for new normal activities after the Pandemic, especially in higher education. Although video conferences have been successfully implemented as communication tools during online activities, the challenges come from the attractiveness of online learning. Augmented reality as novel technology is introduced to increase student engagement to solve the issues. This paper has presented the measurement process of acceptance of AR in video conference-based learning. The University Students as participants have shown their interest in adopting new learning technology, especially when during the video conference session. 170 university students have filled out the questionnaire from UTAUT2 after using the AR. The research has been conducted in video-based learning (in the introduction session). The data was taken from four online classes, five majors of the study program, and 17 different demographic areas. The data has been compiled with UTAUT2 and represent performance expectancy, effort expectancy, social influence, facilitating condition, hedonic motivation, habit, and the last is, investigating the influence on their behavioral intention.

The result is accepted with positive acceptance from the study but varied insignificancy. Performance expectancy, hedonic motivation, and habits are significant positive acceptance constructs. Effort expectancy, social influence, and facilitating conditions get a positive acceptance but are insignificant. The performance expectancy of students is positive and significant because AR technology represents the new approach to E-commerce and is related to the content given. The hedonic motivation is positive and significant because AR represents cutting-edge technology, visual appeal, and a useful combination of video conference-based learning. The habits are positive and significant because AR is not relatively new in participant experience. They are already experienced in such technology as google street view, Snapchat, and Instagram filters, but not in the education context. The effort expectancy is positive but insignificant because most participants are from younger generations, but not all are technology savvy. The social influence is positive but insignificant because the technology is relatively new and needs time to convince related influence partners. The facilitating condition is positive but insignificant because AR technology is relatively new in the University, including the IT infrastructure, and team related.

The implication of this research will be used to consider top-level management in university that conducts full online/distance learning. Implementation of MOOC in several country can be considered. This empirical study also contributes to consumer acceptance of AR technology in education. Nevertheless, the study's remaining factors like age and majors indicated that many participants are well known in digital literacy, which implies future research with younger learners like high school since video conferences are widely implemented in school areas.

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